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Document Name: CGA C-12: Qualification Procedure for Acetylene Cylinder Design

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Standards Body: Compressed Gas Association

APPROVED

Official Incorporator:
The Executive Director
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

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CGA C-12—1994
(OBSOLETE)

QUALIFICATION PROCEDURE FOR ACETYLENE CYLINDER DESIGN

THIRD EDITION

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NOTE—Technical changes from the previous edition are underlined.

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1 Introduction

1.1

These qualification tests are to be used by the manufacturer of acetylene cylinders as required in the Hazardous Materials Regulations and the specifications for acetylene cylinders as prescribed by the Department of Transportation (DOT) in the United States *Code of Federal Regulations*, Title 49 Parts 100-199 [1][1]. In Canada the specifications for acetylene cylinders are prescribed in Canadian Standards Association (CSA) Standard "CAN/CSA B339/M88 - Cylinders, Spheres and Tubes for the Transportation of Dangerous Goods [3]." This standard is mandated by the Transportation of Dangerous Goods (TDG) Regulations [2] of Transport Canada (TC).

1.2

The regulations in 49 CFR 173.303 and CSA B339 specify that acetylene cylinders shall consist of metal shells filled with a porous material and this material must be charged with a suitable solvent. The cylinders containing the porous material and solvent, and representative samples of cylinders charged with acetylene, shall be tested with satisfactory results in accordance with this pamphlet.

1.3

The regulations also in 49 CFR 173.34 and CSA B339 specify that acetylene cylinders must be equipped with pressure relief devices capable of preventing a rupture of the normally charged cylinder when subjected to a fire test conducted in accordance with this pamphlet.

1.4

The tests outlined in 5.1, 5.2, and 5.3 are the tests required to prove that the porous material, hereafter called filler, as installed in a completed cylinder with solvent and acetylene, will: (1) adequately stabilize acetylene by preventing progressive decomposition within the filler when subjected to an internal flash or severe impact; and (2) not disintegrate or sag when wet with solvent and subjected to normal service (simulated transportation vibrations). These tests fulfill the requirements of the regulations found in 49 CFR 173.303 and CSA B339.

1.5

The test outlined in 5.4 fulfills the requirements of 49 CFR 173.34 and CSA B339.

2 Scope

2.1

The four tests in 5.1 through 5.4 are required to be conducted when there is a new cylinder design or a significant design change.

2.2

These tests are to be conducted, and the cylinders must pass all four tests, prior to starting quantity production and introduction of a specific cylinder model into service.

2.3

Cylinders to be tested must be selected from a pilot production run of cylinders of a sufficiently large quantity to permit the use of planned production equipment and procedures. Cylinders to be tested will be typical of those produced in an actual production operation.

---

[1] References are indicated by bracketed numbers and are listed in the order of appearance. See Section 6, References

2.4

All test cylinders are to be complete and of a quality suitable for service, including shell, filler, solvent, valve, core hole packing, pressure relief devices and painting.

2.5

Cylinders used in any of these tests must be scrapped.

3 Information to be recorded

3.1 Cylinder design description

The following information must be recorded and placed in a file covering each new cylinder design and each significant design change. Provide sufficient detail to permit cylinders of that model or design to be identified.

3.1.1

A brief general description of the filler, including (a) nature of ingredients, (b) method of inserting filling material into shell, (c) design, (d) porosity range, (e) the actual porosity determined by tests on a completed cylinder, and (f) a list of the manufacturer's maximum clearance limits between the filler and shell for each cylinder size.

3.1.2

Drawings of the cylinder giving full details, including (a) inside diameter, (b) wall thickness, (c) length, (d) manufacturer's rated gas capacity when charged to 250 psig at 70°F (1720 kPa at 21.1°C), (e) interior shell volume in pounds water capacity (maximum and minimum), (f) tare weight of the cylinder (maximum and minimum), (g) weight of solvent to be added (maximum and minimum), (h) core hole size, and, if used (i) core hole packing, material, size and quantity.

3.2 Results of tests

A record of the tests must be prepared, dated, and signed by the person responsible for performing the tests and must show the following:

3.2.1

The number of cylinders of each type tested, date of tests, description of tests (including such items as pressure, drop height, clearance measurements, number of cycles, heat input, proof of ignition, etc.), and results of the tests.

3.2.2

If retesting is required because a model fails any of the tests, the same information must also be recorded for those tests.

4 Acceptable test results

4.1

All cylinders required for each of the four tests must pass.

4.2

If any of the specified sampling of cylinders fail a particular test, that test shall be repeated on an equivalent sampling of cylinders selected from the pilot production run. Table 1 shows the minimum number of cylinders required for the four tests.

Table 1—Minimum number of cylinders required for tests

Test	Cylinders
Mechanical Strength of Filler	3
Flashback	3
Impact Stability	1 (Largest)
Fire	3

4.3

If any of the retest cylinders fail and the cause of failure is found to be a design or manufacturing deficiency, the problem must be corrected. Another pilot production run shall be made, and all four tests shall again be conducted on the specified number of cylinders. All cylinders must pass.

5 Tests

5.1 Proof of mechanical strength of filler test

5.1.1

This test is to prove that the filler will withstand shipment without developing excessive or harmful settling, sagging, disintegration, or cracking.

5.1.2

Once a design has been qualified, this test must be successfully performed again if there are significant design changes to the filler or interior shape of the cylinder.

5.1.3

Three completely assembled cylinders of the largest standard production size shall be selected and tested. They shall be charged with solvent to the maximum permitted by the design.

5.1.4

After removal of the core hole packing, the clearance between the top of the filler and the inside top of the cylinder shell (top clearance) shall be measured in two locations 180° apart and recorded. A reference mark shall be placed on the spud to indicate the points of measurement. Measurements performed after the test shall be made at the same points.

5.1.5

The cylinder shall be placed upright on an apparatus which is so arranged as to subject the cylinder to successive free drops onto a steel or cast iron surface solidly supported by a concrete foundation.

5.1.6

The cylinder shall be subjected to either:

5.1.6.1

Five thousand consecutive free drops of 3 inches (76.2mm); or

5.1.6.2

One hundred thousand consecutive free drops of 1.5 inches (38.1mm).

5.1.7

The top clearance shall then be remeasured at the two points described in 5.1.4. The measurements shall be recorded.

5.1.8

The cylinder shall be sectioned longitudinally in the center area and the filler carefully examined.

5.1.9

Requirements to pass this test include:

5.1.9.1

Top clearance shall not have increased more than 1/16 inch (0.062 inch; 1.575 mm) for cylinders at least 36 inches (914.4 mm) long, nor more than 1/32 inch (0.031 inch; 0.787 mm) for cylinders less than 36 inches (914.4mm) long; but in no case shall the final clearance exceed that allowed by the DOT and TC specification.

5.1.9.2

The filler shall not exhibit excessive or harmful disintegration, cracks, or voids.

5.2 Flashback test

5.2.1

This test determines whether or not a design will withstand and contain an internal decomposition. It is a test of the complete design, as fully assembled, including the shell, filler, solvent, pressure relief devices, valve, and core hole packing, if any. The cylinder design should minimize release of the fuse plug during this test.

5.2.2

This test must be performed on the pilot run of each nominal diameter of a cylinder design to be produced. If cylinders of the same design and diameter are subsequently produced which are of greater length, and thus greater gas capacity, the largest cylinders of the new production shall be tested for qualification.

5.2.3

After a design has been qualified, this test must be conducted again if there is any significant design change which includes:

- the number, size, or design of pressure relief devices;
- relocation of pressure relief devices one inch or more from previously tested location;
- a 25% change in thickness of the shell or heads;
- change in spud (or flange) of either 40% in weight or 25% in diameter;
- size increase of 50% or more in the volume of the core hole;
- change in top or bottom head shape, e.g., from convex to concave to pressure;
- change in type of solvent;
- increase in manufacture's rated acetylene capacity of 5% or more;
- a change in an amount of solvent of 5% or more.

Any significant change in filler formulation, manufacturing techniques, or any other cylinder change not listed above which could affect the capacity of the cylinder to withstand this test will require additional testing on the cylinder of the largest standard production size.

5.2.4

The three cylinders to be tested must meet the following requirements:

5.2.4.1

Cylinders must comply with DOT and TC regulations and have the maximum permitted longitudinal clearance (maximum allowed by the manufacturer for that design) between shell and filler. The actual clearance must be included in the test report.

5.2.4.2

Cylinders must be charged with the maximum allowable solvent and to the manufacturer's maximum rated acetylene capacity.

5.2.4.3

The cylinders must be held at a temperature of 80° to 90°F (26.7° to 32.2°C) until they reach thermal equilibrium which normally produces a pressure of 280 to 305 psig (1930 to 2100 kPa). This can be achieved by immersion in a water bath for 18 to 36 hours before testing.

5.2.4.4

The flashback spark shall be applied as soon as possible after the cylinder is removed from the heating environment, but in no case shall the pressure drop more than 5% of the maximum pressure achieved before the spark is applied.

5.2.5

Cylinders shall be tested as follows:

5.2.5.1

A flashblock assembly similar to that shown in Fig. 1 shall be connected to the cylinder valve outlet. The internal volume of the flashblock assembly should be no less than in Fig. 1.

5.2.5.2

Air shall be purged from the flashblock assembly, and the cylinder valve allowed to remain fully open. This can be achieved by pressurizing and discharging the test assembly for 5 cycles.

5.2.5.3

An electric current (110 volts AC or 24 volts DC) shall be applied to fuse the ignition wire and cause dissociation of the acetylene in the flashblock. An ammeter wired into the circuit and observed during ignition will provide positive evidence that the ignition wire has fused, thus indicating that a flash was initiated.

5.2.5.4

The cylinder shall be allowed to stand for at least 24 hours and then examined.

5.2.6

The requirement for passing this test is that the cylinder shall not rupture.

5.2.6.1

The fuse plugs may release during this test.

5.2.7

The cylinder test shall be validated as follows:

5.2.7.1

If the cylinder has not ruptured it shall be discharged, its valve shall be removed, and the filler under the valve examined.

5.2.7.2

The test is valid if the filler or core hole packing shows a carbon deposit indicating that the flashback entered the cylinder.

5.2.7.3

If no carbon deposit is visible, which would indicate that exposure to a flashback did not occur, the test must be repeated on an equivalent cylinder.

5.3 Impact stability test

5.3.1

This is a one-time test for a given filler-solvent system.

5.3.2

One cylinder of the largest standard production size to be manufactured must be tested.

5.3.3

The cylinder must be charged with the maximum allowable solvent and to the manufacturer's maximum rated acetylene capacity.

5.3.4

The cylinder shall be tested as follows: the cylinder shall be placed in a horizontal position and subjected to an impact sufficient to produce a dent (not a break) in the cylinder sidewall. The depth of the dent shall be at least one-fourth of the cylinder diameter. The dent shall be produced either by a drop weight impact or an explosive charge impact.

Appendix B can be used to help determine the correlation between explosive charge and drop weight impact.

5.3.4.1

Impact by drop weight method.

5.3.4.1.1

The cylinder to be tested should be placed horizontally and braced to receive the impact. The weight should be dropped from a sufficient height to impart the desired impact. The weight's impact surface shall be smooth and convex with a diameter of approximately one-third the diameter of the cylinder.

5.3.4.2

Impact by explosive charge method.

5.3.4.2.1

An explosive such as (a) 40% gelatin dynamite or (b) Tovex (du Pont) shall be used.

5.3.4.2.2

Place the explosive on the cylinder about one-third of the cylinder length from the top of the cylinder

5.3.4.2.3

An electric blasting cap shall be inserted into the explosive, and the explosive and blasting cap shall then be mud-capped.

5.3.4.2.4

The mud cap shall be made of heavy, wet clay in an open-top, open-bottom truncated cone mold with 5 inches (127.0 mm) and 8 inches (203.2 mm) top and bottom diameters, respectively, that is 7 inches (177.8 mm) high. The mud cap is pushed out of the mold, over the explosive, and pressed down around the explosive, sealing it on the cylinder being tested.

5.3.4.2.5

The electric blasting cap shall then be caused to function.

5.3.5

At least 24 hours after the impact, the gas shall be released from the cylinder and the cylinder sectioned longitudinally through the dented area for examination.

5.3.6

Requirements to pass this test are as follows:

5.3.6.1

Measure the diameter and depth of the dent. If the depth dimension is approximately of the size indicated in 5.3.4 above, the test is acceptable, provided that:

5.3.6.1.1

There shall not be progressive acetylene decomposition through the filler, however, evidence of decomposition immediately under the dent is acceptable.

5.3.6.1.2

There shall not be any destruction of the filler except in the area of the dent.

5.3.6.1.3

There shall not be a crack in the shell.

5.4 Fire test

5.4.1

Three cylinders of the largest rated capacity of each nominal diameter, but otherwise of identical design, shall be tested. Test procedure may be either the Chimney Fire Test Method (5.4.6) or Wood Bonfire (5.4.7)

5.4.2

After a design has been qualified, this test must be conducted again if there is any significant design change which includes:

- the number, size, or design of pressure relief devices;
- relocation of pressure relief devices one inch (25.4 mm) or more from previously tested location;
- a 25% change in thickness of the shell to heads;
- change in spud (or flange) of either 40% in weight or 25% in diameter;
- size increase of 50% or more in the volume of the core hole;
- change in top to bottom head shape, e.g., from convex to concave to pressure;
- change in type of solvent;
- increase in manufacturer's rated acetylene capacity of 5% or more;
- a change in an amount of solvent of 5% or more.

Any significant change in filler formulation, manufacturing techniques, or any other cylinder change not listed above which could affect the ability of the cylinder to withstand this test will require additional testing on the cylinder of the largest standard production size.

5.4.3

Each cylinder shall be charged with the maximum allowable solvent and to the manufacturer's maximum rated acetylene capacity.

5.4.4

Each cylinder shall be held at a temperature of at least 65°F (18.3°C) for at least 18 hours before testing.

5.4.5

The pressure and shell temperature of the cylinder immediately prior to the test shall be recorded.

5.4.6 Chimney fire test method

The chimney fire test shall be designed to simulate, as nearly as possible, the fire test and rate of temperature rise as given in Fig. 2 and Appendix XI of ASTM E-119, *Standard Fire Tests of Building Construction and Materials*, [4] for the first 15 minutes of the fire test.

5.4.6.1

An acceptable apparatus is shown in Figs. 2 through 12. Figs. 13 through 18 show the apparatus in various stages of assembly. This apparatus will produce a flue gas temperature of approximately 1200°F (648.9°C). The following are recommended procedures for assuring test uniformity.

5.4.6.1.1

While this particular fire test apparatus is less sensitive to wind than others, it is still somewhat sensitive to wind velocity and wind direction. Therefore, it should be calibrated at the start of each day's testing. One method of calibration is to place an uncharged cylinder of the size to be tested within the apparatus. Ignite the fuel and make adjustments to the draft and fuel controls to assure that flue gas temperatures reach 1200°F (648.9°C) in 5 minutes. Alternative methods of calibration may be acceptable.

5.4.6.1.2

One acceptable method of monitoring the temperature is to equip the apparatus with two thermocouples located 180° from each other and on a level with the mid-point of the test cylinder and at the center of the annular space between the inner wall of the apparatus and the cylinder wall.

5.4.6.1.3

For greater convenience, the portion of the apparatus surrounding the cylinder can be made in two sections with the joint situated at approximately the top of the test cylinder. This permits the gauge line and thermocouple leads to be brought out through slots in the joint. A good technique suggests that the portion of the gauge line within the chimney be of steel (to prevent melting), positioned so that it is not over the fuse plug. The entire gauge line should be filled with water to avoid line flashes which would rupture the gauge. See Fig. 2.

5.4.6.1.4

Experience has shown that the burner should be capable of burning propane or other fuel gas at a rate up to 370 000 Btu/hour when testing 12 inch (304.8 mm) diameter cylinders. The actual required fuel rate could vary for each combination of apparatus and cylinder size.

5.4.6.1.5

Insulating the exterior wall of the apparatus will reduce heat loss through the wall and further improve uniform heating of the cylinder.

5.4.6.1.6

The cylinders should be placed approximately in the center of the test apparatus to improve uniform heating of the cylinder.

5.4.6.2

The manufacturer shall keep a record of the design and performance characteristics of the fire test equipment. This record shall show construction details, rate of temperature rise of the cylinder sidewall in tests on uncharged cylinders, and the rate of fuel value input under these conditions.

5.4.6.3

The rate of temperature rise need not be recorded during each test, but records shall be kept showing the rate of fuel input in Btu/hour, and these shall be related to temperature rise data developed on uncharged cylinders.

5.4.6.4

The cylinder shall stand upright on a noncombustible base within the enclosure.

5.4.6.5

The cylinder shall not be subject to direct flame impingement.

5.4.6.6

The pressure relief devices shall not be especially shielded from the heat.

5.4.6.7

Requirements to pass this test include:

5.4.6.7.1

One or more pressure relief devices must release during the course of the test.

5.4.6.7.2

The cylinder shall not rupture.

5.4.6.8

If the cylinder falls off the base, or is tipped over because of a localized split or release of a fuse plug, the test is considered acceptable.

5.4.7 Wood bonfire test method

The basic intent of the Wood Bonfire Test Method is to provide a means of exposing cylinders to an actual fire environment. The wood bonfire test method facilitates testing of cylinders in horizontal position that reduces the potential for the loss of test equipment in the event of cylinder rupture.

5.4.7.1

The test cylinder shall be secured, if necessary, in a horizontal position to prevent movement for the duration of the test.

5.4.7.2

The wood used in this test must be kiln dried. The sizes and approximate number of pieces used in the horizontal fire test varies with the cylinder size. A breakdown by size is listed below. See figs; 19, 20 and 21 for proper placement

Cylinder Diameter	**Wood Quantity and Size**	
4 to 6 inches	20 pieces	1" x 1" x 24"
	20 pieces	1" x 1" x 18"
	40 pieces	1" x 1" x 12"
7 to 8 inches	40 pieces	1" x 2" x 40"
	40 pieces	1" x 2" x 30"
	80 pieces	1" x 1" x 12"
10 inches	45 pieces	1" x 2" x 48"
	45 pieces	1" x 2" x 30"
	90 pieces	1" x 1" x 12"
12 inches	50 pieces	1" x 2" x 48"
	50 pieces	1" x 2" x 30"
	100 pieces	1" x 1" x 12"

5.4.7.3

Kerosene (1 to 2 quarts) should be applied to the wood stack in a uniform manner and allowed to absorb for approximately 2 minutes prior to ignition.

5.4.7.4

As this test method is sensitive to wind conditions, a wind shield should be placed as appropriate to prevent excessive drift of the flames.

5.4.7.5

Verify that all pertinent information has been recorded both for the system to be tested and for the test method used.

5.4.7.6

Open cylinder valve and note final pretest pressure.

5.4.7.7

Ignite fuel and record starting time.

5.4.7.8

Record internal pressure to insure a minimum of 25 psi (172.4 kPa) pressure increase before the relief device functions.

5.4.7.9

Elapsed time to completion of test shall be recorded. It will be noted that the flames issuing from the fuse plugs will gradually decrease in length until they are only 8 to 10 inches long and have no apparent velocity. This is an indication that all of the acetylene has been discharged from the cylinder and that the flame is caused primarily by acetone being vaporized from the filler. Even though the acetylene has apparently all been driven from the cylinder, the cylinder should not be approached for 24 hours.

5.4.7.10 Acceptance criteria

The pressure relief device shall function within 10 minutes preventing rupture (see 5.4.7.10.2 below) of the cylinder for all three cylinders tested. Verification of the pressure relief device functioning shall be made by any suitable means.

5.4.7.10.1

Secondary venting from locations other than the pressure relief device (such as plastic valve components) is not considered a failure, and retest is not required.

5.4.7.10.2

A "localized split" is not considered a failure. Such a split may be caused by localized over heating. This is not a major tearing of the cylinder.

5.4.7.10.3

If the cylinder becomes dislodged from its test position in a manner as to reduce its exposure to the fire, the test must be aborted and a retest initiated with a new cylinder.

6 References

[1] *Code of Federal Regulations*, Title 49 CFR Parts 100-199 (Transportation), U.S. Department of Transportation. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[2] CAN/CSA B339-88, *Cylinders, Spheres and Tubes for the Transportation of Dangerous Goods*, Canadian Standards Association, 178 Rexdale Blvd., Rexdale, Ontario, Canada, M9W 1R3.

[3] *Transportation of Dangerous Goods Regulations*, Supply and Services. Canada, Ottawa, Ontario, Canada K1A 0S9.

[4] ASTM E-119, *Standard Fire Tests of Building Construction and Materials*, ASTM, 1916 Race Street, Philadelphia, PA 19103.

Appendix A—Burner and ignition system

FOR

Chimney Fire Test Burner Specification

Eclipse #100421 ring burner assembly or equivalent, equipped for use with propane (including ring burner, mixer body and supports). Manufactured by Eclipse Inc., 1100 Buchanan St., Rockford, Illinois 61103. (815) 877-3031.

NOTE: Equip the propane fuel supply cylinder with a flow meter, regulator and tubing capable of delivering and measuring a minimum flow of 96 cubic feet per hour of propane (equivalent to 240 000 Btu per hour).

Ignition System Components

(1) Oil burner ignition transformer, 110 volt with 10 000 volt secondary. Obtain from a local heating oil contractor.

(2) Electrodes. Maxom #25663 oven spark ignitor electrodes or equivalent. Two are required. Manufactured by Maxom Corporation, 201 East 18th St., Muncie, Indiana 47302. (317) 284-3304.

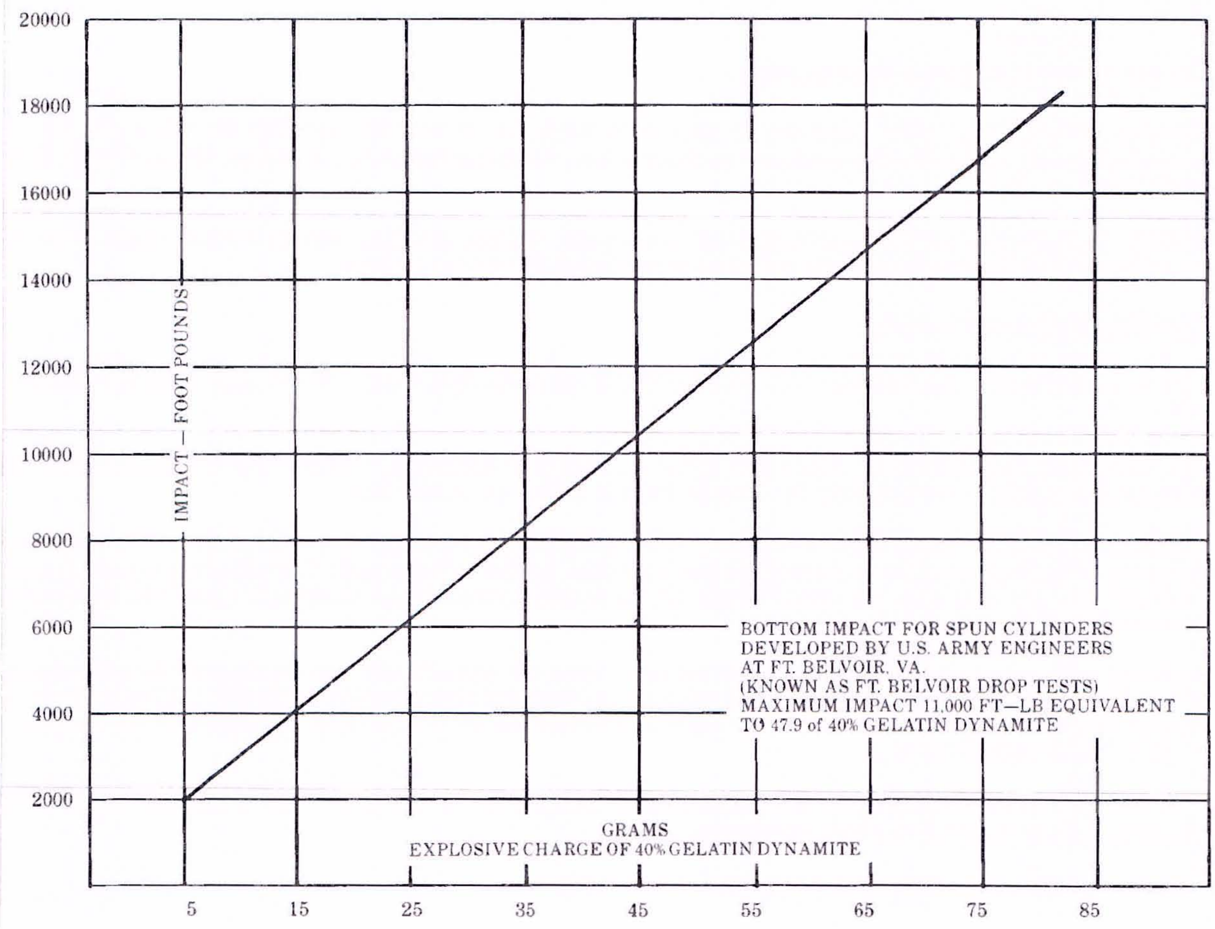
NOTE 1: To locate the ignitors, proceed as follows: With the base and center assembly in place, drill two 7/8-inch (22 mm) diameter holes, 8 inches (203 mm) above the bottom of the base, located 20 inches apart. The holes must be drilled through both the outer and inner walls and aligned radially. On the outside member, weld a 1/2-inch (12.7 mm) NPT half-coupling centered over the hole.

NOTE 2: When using the ignitor system, align the holes, insert the electrode and form the electrode wires inward and downward to provide 1/4 inch (6.35 mm) space between the electrodes and approximately 1/2-inch (12.7 mm) space between the electrodes and the top of the burner. Tighten the compressor fitting on the electrode against the half-coupling to hold the ignitor in this location.

(3) Electrode connectors. Connect the two electrodes using automotive ignition cable or equivalent; one cable running to each electrode from the transformer.

NOTE: The cable must be copper conductor type, not resistor type.

Appendix B—Correlation of drop weight impact versus explosive charge



BOTTOM IMPACT FOR SPUN CYLINDERS
DEVELOPED BY U.S. ARMY ENGINEERS
AT FT. BELVOIR, VA.
(KNOWN AS FT. BELVOIR DROP TESTS)
MAXIMUM IMPACT 11,000 FT—LB EQUIVALENT
TO 47.9 of 40% GELATIN DYNAMITE

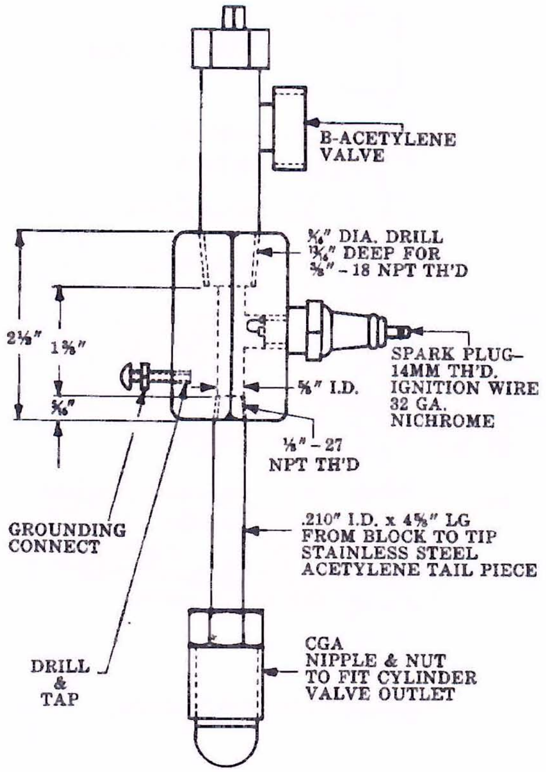


Figure 1—Flashback test flashblock assembly for acetylene cylinders

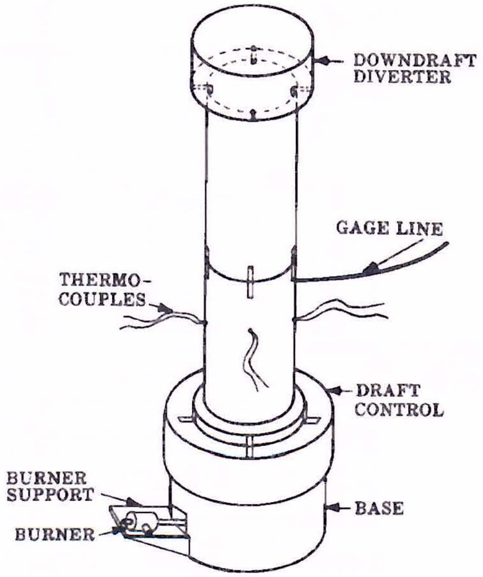


Figure 2—Isometric view of fire test apparatus assembly

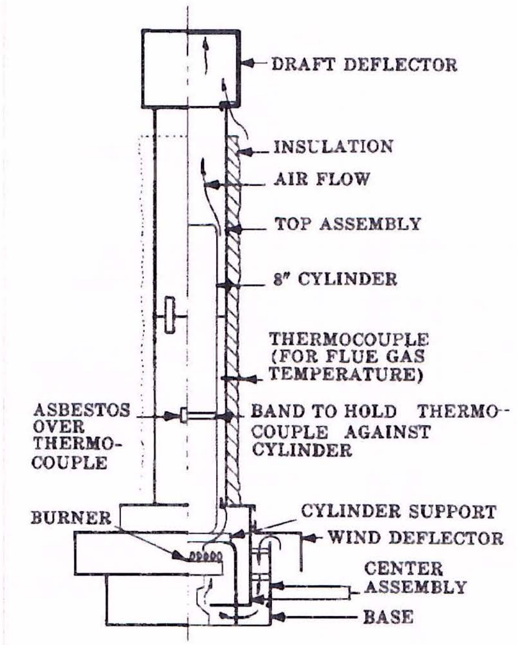


Figure 3—Chimney assembly

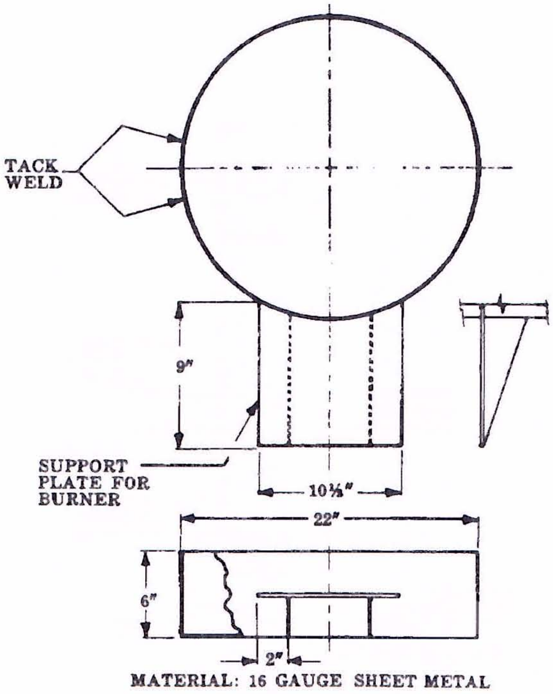


Figure 4—Base

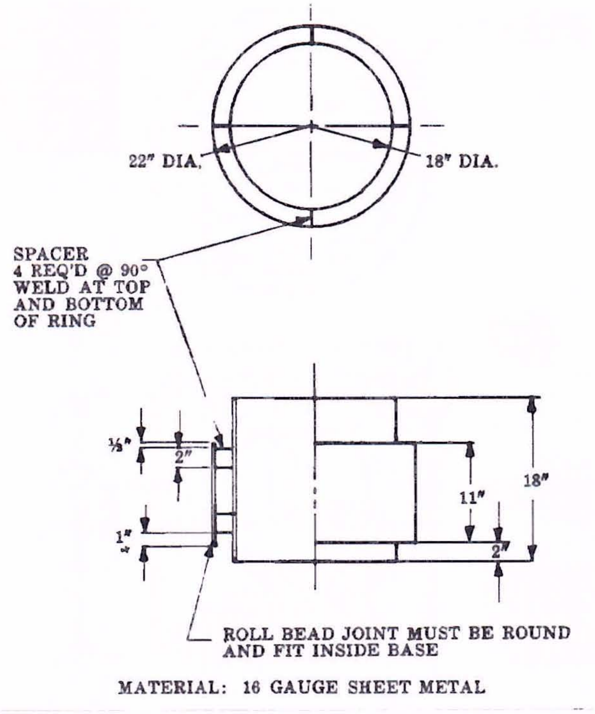


Figure 5—Center assembly

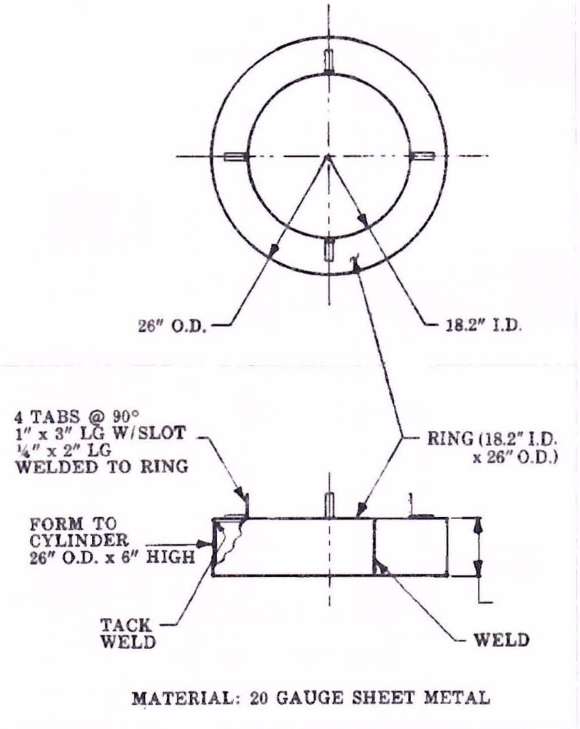


Figure 6—Bottom wind deflector

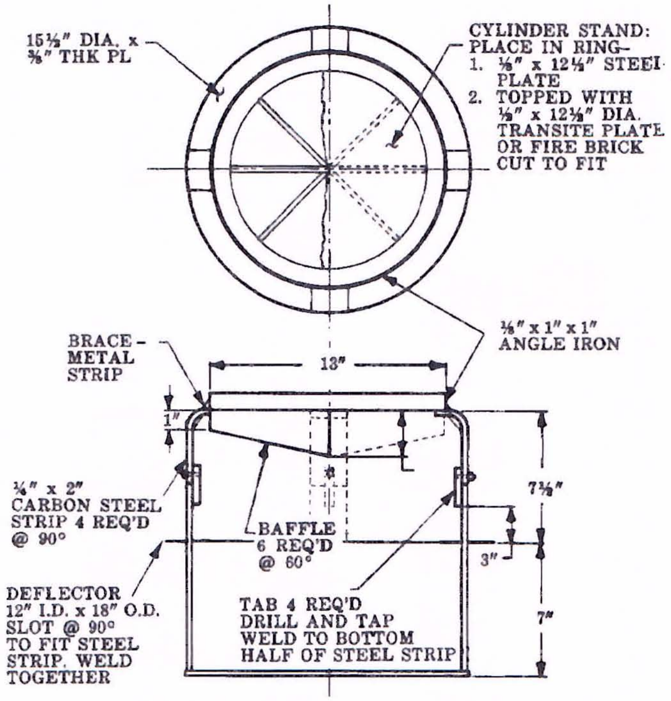

15½" DIA. x
⅜" THK PL
CYLINDER STAND:
PLACE IN RING–
1. ⅛" x 12½" STEEL PLATE
2. TOPPED WITH ½" x 12⅛" DIA. TRANSITE PLATE OR FIRE BRICK CUT TO FIT
BRACE - METAL STRIP
13"
⅛" x 1" x 1" ANGLE IRON
1"
¼" x 2" CARBON STEEL STRIP 4 REQ'D @ 90°
BAFFLE 6 REQ'D @ 60°
7⅛"
3"
7"
DEFLECTOR 12" I.D. x 18" O.D. SLOT @ 90° TO FIT STEEL STRIP. WELD TOGETHER
TAB 4 REQ'D DRILL AND TAP WELD TO BOTTOM HALF OF STEEL STRIP

Figure 7—Cylinder stand

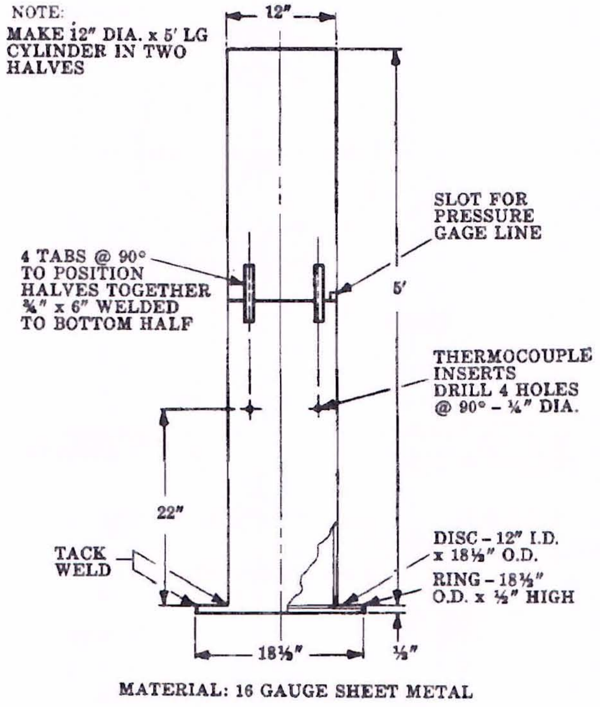

NOTE:
MAKE 12" DIA. x 5' LG CYLINDER IN TWO HALVES
12"
SLOT FOR PRESSURE GAGE LINE
4 TABS @ 90° TO POSITION HALVES TOGETHER ¾" x 6" WELDED TO BOTTOM HALF
5'
THERMOCOUPLE INSERTS DRILL 4 HOLES @ 90° - ¼" DIA.
22"
TACK WELD
DISC - 12" I.D. x 18⅛" O.D.
RING - 18⅛" O.D. x ½" HIGH
18⅛"
½"
MATERIAL: 16 GAUGE SHEET METAL

Figure 8—Top assembly for 8-inch diameter cylinders

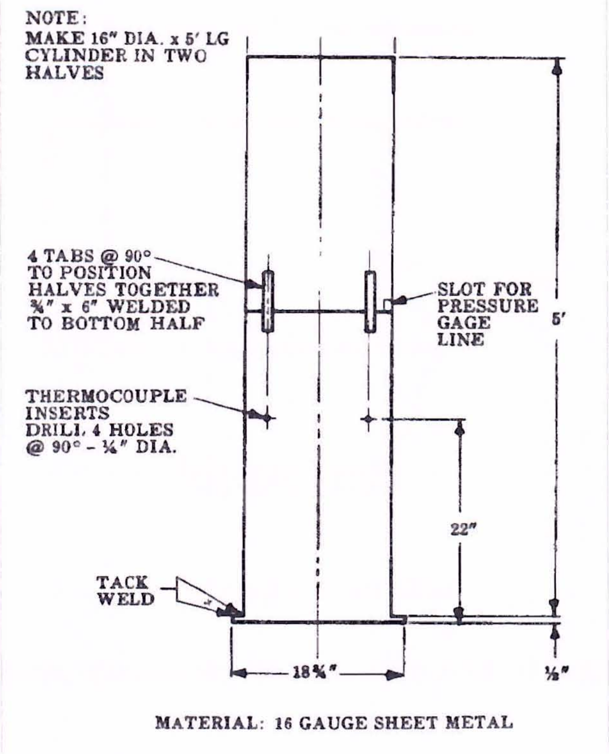
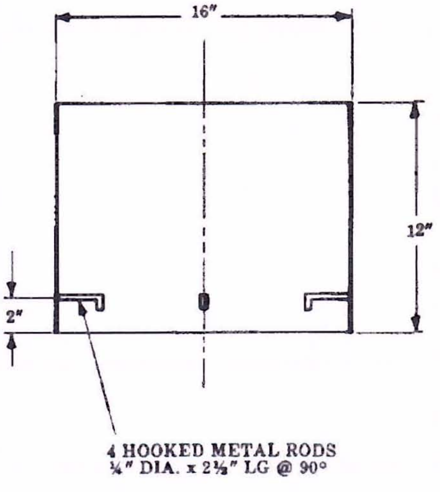

NOTE:
MAKE 16" DIA. x 5' LG CYLINDER IN TWO HALVES
4 TABS @ 90° TO POSITION HALVES TOGETHER ¾" x 6" WELDED TO BOTTOM HALF
SLOT FOR PRESSURE GAGE LINE
5'
THERMOCOUPLE INSERTS DRILL 4 HOLES @ 90° - ¼" DIA.
22"
TACK WELD
18¾"
½"
MATERIAL: 16 GAUGE SHEET METAL

Figure 9—Top assembly for 12-inch diameter cylinders



MATERIAL: 16 GAUGE SHEET METAL

Figure 10—Draft deflector for 8-inch diameter cylinders

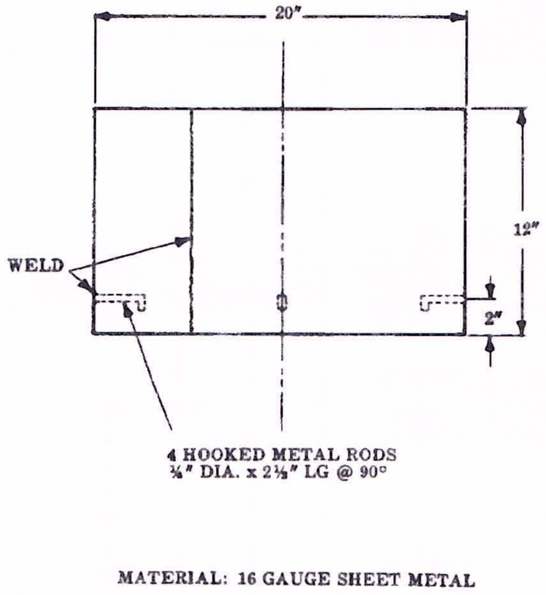


Figure 11—Draft deflector for 12-inch diameter cylinders

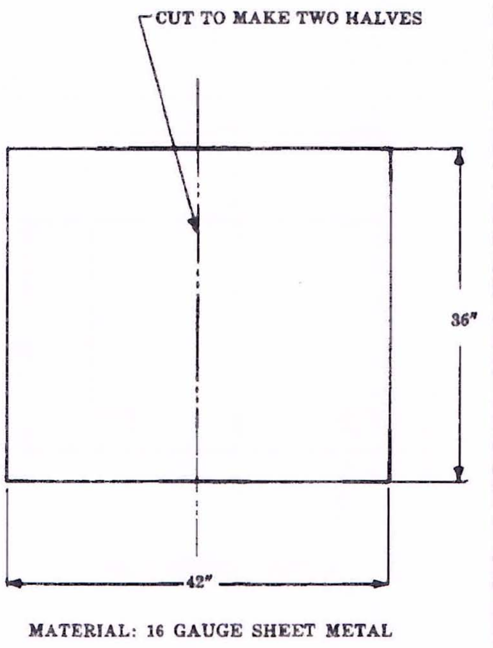


Figure 12—Secondary wind deflector

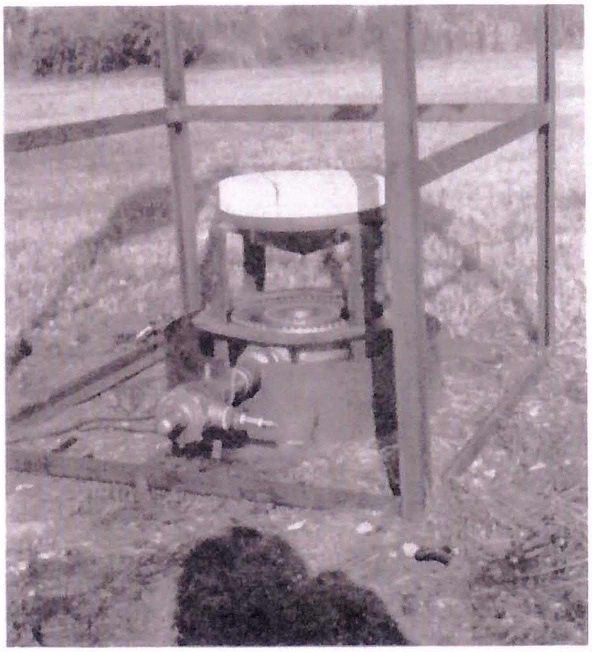


Figure 13—Wheel type burner unit with base and fire brick cylinder support installed. Personnel protection frame surrounds unit.

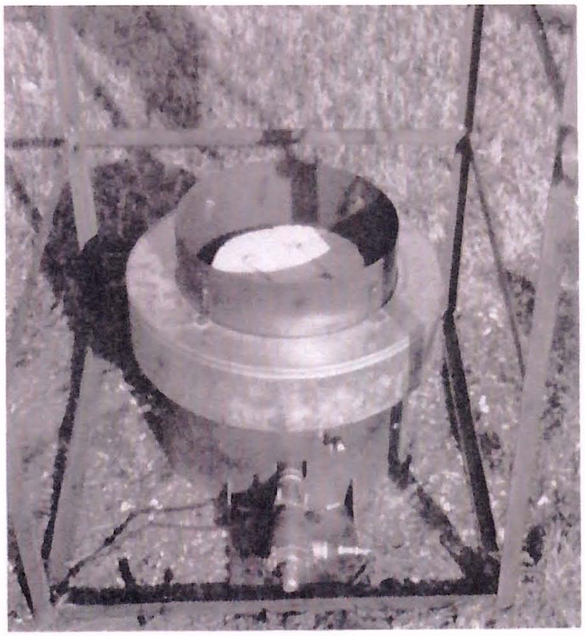


Figure 14—Burner unit with bottom sind deflector installed

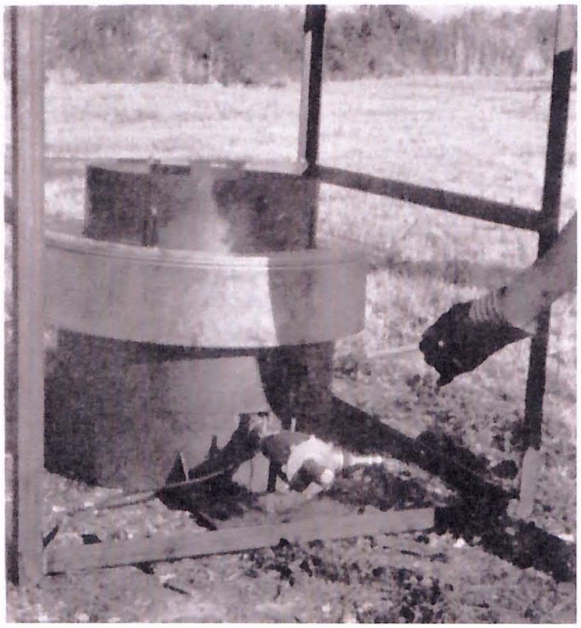


Figure 15—Spark ignitier being installed through base

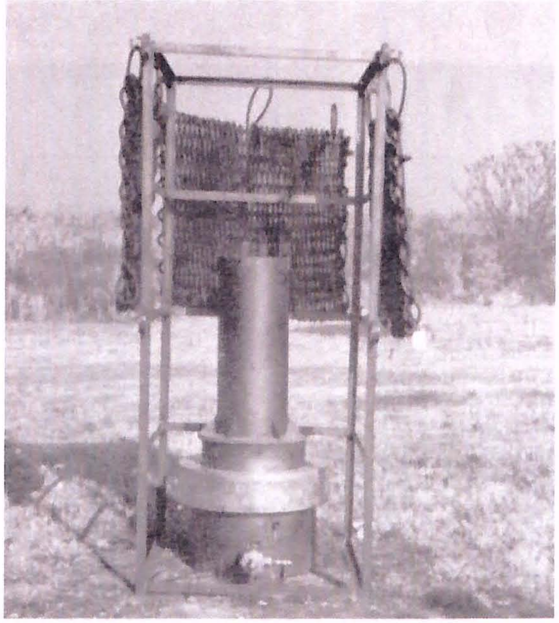


Figure 16—Bottom chimney section installed. Blasting mats for personnel protection.

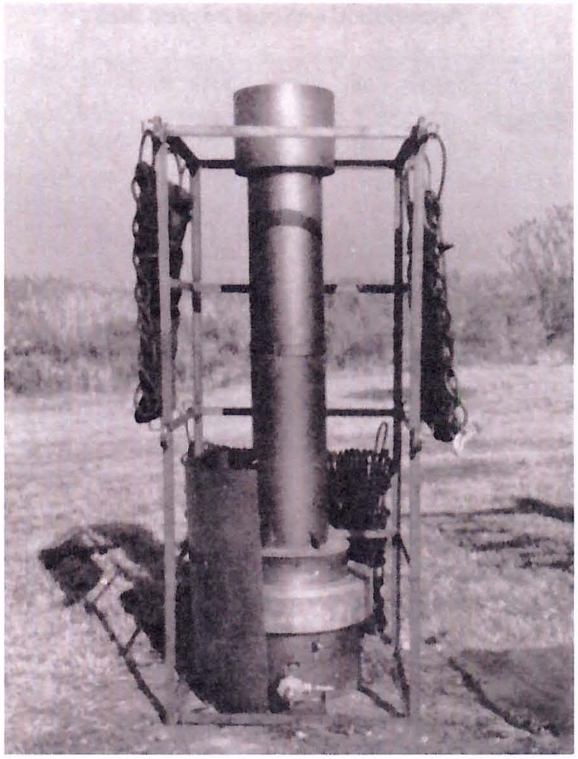


Figure 17—Top chimney section with downdraft deflector installed

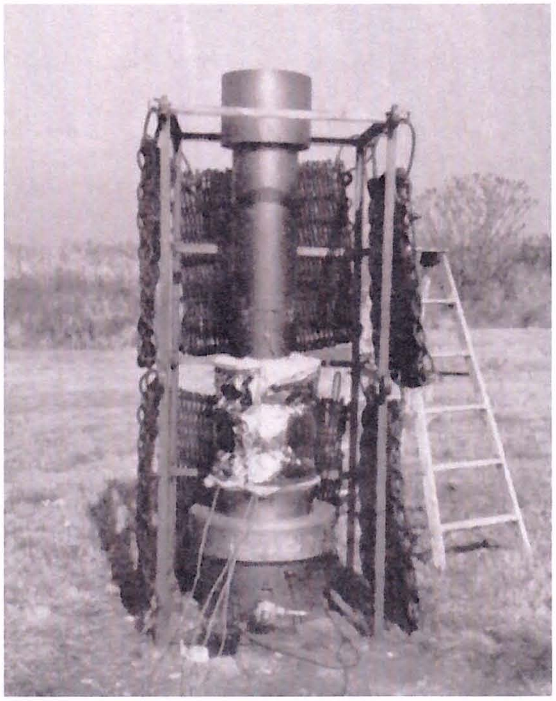


Figure 18—Lower isulation, two flue gas and two cylinder surface thermocouples, spark igniter and propane fuel line installed

Appendix C—Wood bonfire test

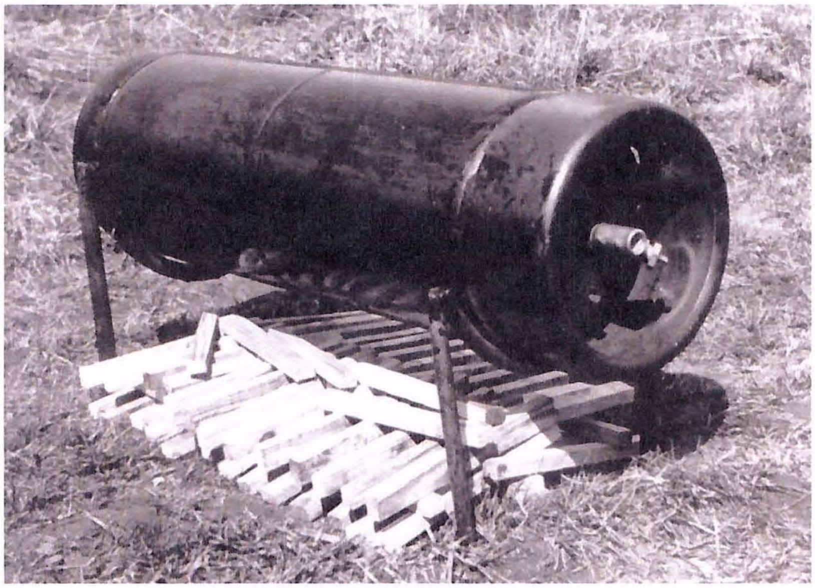


Figure 19—Wood bonfire test - view of wood stack for 8" cylinder - step 1

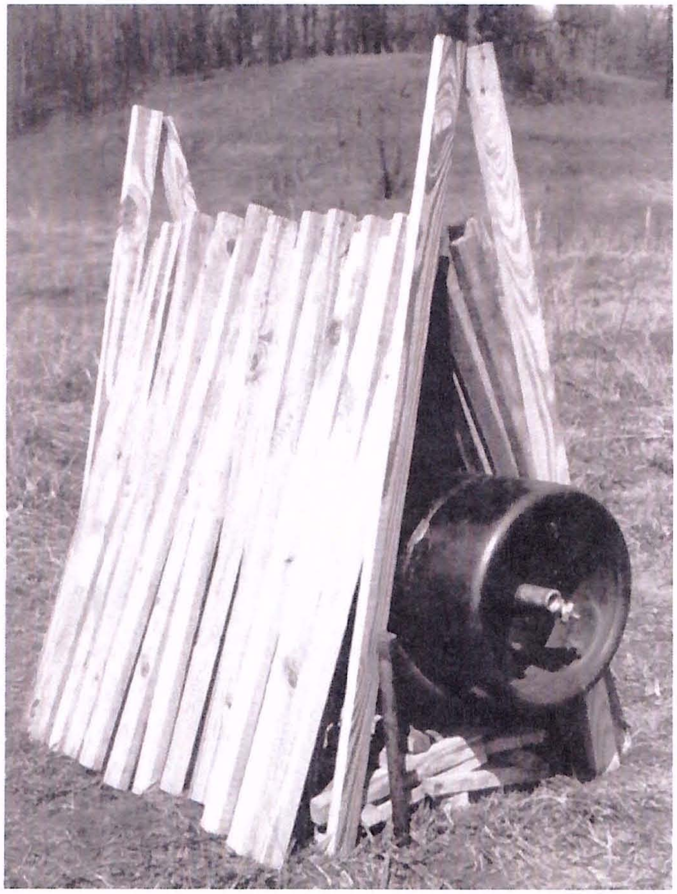


Figure 20—Wood bonfire test - view of wood stack for 8" cylinder - step 2

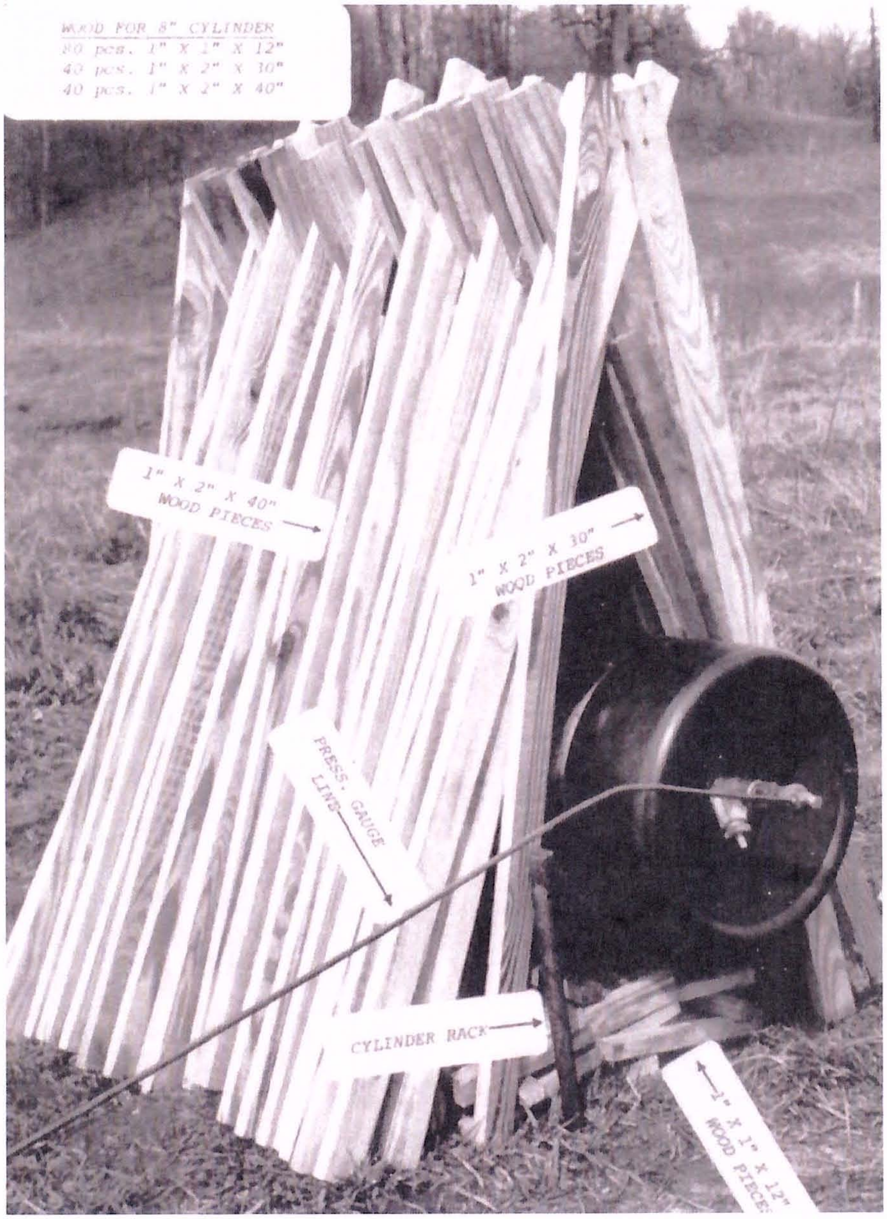


Figure 21—Wood bonfire test - view of wood stack for 8" cylinder - step 3